

THE CHALCIDOID PARASITES (HYMENOPTERA, CHALCIDOIDAE) OF  
ECONOMICALLY IMPORTANT *LIRIOMYZA* SPECIES  
(DIPTERA, AGROMYZIDAE) IN NORTH AMERICA

JOHN LASALLE\* AND MICHAEL P. PARRELLA

(JL) Department of Entomology, University of California, Riverside, California 92521;  
(MPP) Department of Entomology, University of California, Davis, California 95616.

---

*Abstract.*—Twenty-four species of chalcidoid parasites of the five economically important species of *Liriomyza* in North America are reviewed, plus four species which may prove to parasitize these *Liriomyza* species. A key is presented to distinguish these species, and each species is discussed, with host and distributional information given. Species names are corrected to reflect currently applied nomenclature, and a complete list of all names that have been used for these parasites is given, indicating currently recognized names and all other names used for any of these species.

*Key Words:* Agromyzidae, Chalcidoidea, Eulophidae, leafminer, *Liriomyza*, parasite, Pteromalidae

---

Five species of *Liriomyza* (*brassicae*, *huidobrensis*, *sativae*, *trifoliarum*, *trifolii*) are considered to be of economic importance in North America (Spencer 1973, Parrella 1982). Confusion concerning the identity of these *Liriomyza* species has been rectified by several recent papers (Spencer 1981, Spencer and Steyskal 1986, Parrella 1982). The purpose of the present paper is to examine the chalcidoid parasite complex of these leafminers, present a means for the identification of the parasites, and to upgrade the nomenclature of the parasites in light of several recent papers on the systematics of these groups.

A large parasite complex is associated with these leafminers; 24 species of Chalcidoidea are now known from North America. Although keys to identify many of the individual genera and species are available, no

key currently encompasses the entire chalcid fauna of *Liriomyza* parasites. The present paper treats all species of chalcidoid parasites recorded from these leafminer species in North America. An additional four species, *Diglyphus isaea*, *D. carlylei*, *Chrysocharis liriomyzae*, *C. ignota*, are included in this paper because they are either very closely related to included species and may be confused with them, or they are suspected to be parasites of these *Liriomyza* species or become so in the future. A key is presented to distinguish these 28 species, and each species is discussed in the text, with diagnostic characters, and host and distributional information given.

Table 1 gives all names used for the leafminer parasites in the North American literature and indicates: currently valid names; the currently recognized names for species which are no longer considered valid; and all generic combinations (including the valid one) used for any of the specific names.

This paper is not intended to be re-

---

\* Current mailing address: Dr. John LaSalle, CAB International, Institute of Entomology, 56 Queen's Gate, London, SW7 5JR, UNITED KINGDOM.

Table 1. List of all names used for Nearctic *Liriomyza* parasites. Currently valid names in boldface. Generic names in parentheses are other generic names under which a species has been treated in the literature.

---

***acantha*** (Walker), ***Pediobius***  
*aneae* (Walker), *Halticoptera* [misidentification of *H. circulus* (Walker)]  
*agromyzae* (Crawford), *Chrysonotomyia* (*Derostenus*) = *C. punctiventris* (Crawford) [although see discussion in text under *C. punctiventris*]  
***ainsliei*** Crawford, ***Chrysocharis***  
***americanum*** Girault, ***Zagrammosoma***  
*arizonensis* (Crawford), *Chrysonotomyia* (*Derostenus*) = *C. punctiventris* (Crawford)  
***begini*** (Ashmead), ***Diglyphus*** (*Diaulinus*, *Solenotus*)  
*callichroma* Crawford, *Diaulinopsis*  
*cinctipennis* Ashmead, *Closterocerus*  
*circulus* (Walker), *Halticoptera*  
*crassiscapus* (Thomson), ***Chrysocharis***  
***diastatae*** (Howard), *Chrysonotomyia* (*Derostenus*)  
*flavipes* (Ashmead), *Pnigalio*  
***flavoviridis*** Crawford, ***Cirrospilus***  
*formosa* (Westwood), *Chrysonotomyia* (*Achrysocharella*)  
*fullawayi* (Crawford), *Chrysonotomyia* (*Derostenus*, *Achrysocharella*) = *C. formosa* (Westwood)  
***giraulti*** Yoshimoto, ***Chrysocharis***  
***ignota*** Hansson, ***Chrysocharis***  
***intermedius*** (Girault), ***Diglyphus*** (*Solenotus*)  
*isaea* (Walker), ***Diglyphus***  
***lineaticeps*** (Girault), ***Zagrammosoma*** (*Mirzagrammosoma*)  
*liriomyzae* Delucchi, ***Chrysocharis***  
*mallochi* Gahan, *Chrysocharis* = *C. crassiscapus* (Thomson)  
***mirum*** Girault, ***Zagrammosoma***  
***multilineatum*** (Ashmead), ***Zagrammosoma***  
***oscinidis*** Ashmead, ***Chrysocharis***  
*parki* Crawford, *Chrysocharis* = *C. oscinidis* Ashmead  
*patellana* (Dalman), *Halticoptera* [misidentification of *H. circulus* (Walker)]  
*petiolata* (Girault), *Chrysocharis* = *C. giraulti* Yoshimoto  
***pictipes*** (Crawford), ***Chrysonotomyia*** (*Derostenus*)  
***pulchripes*** (Crawford), ***Diglyphus*** (*Solenotus*)  
***punctiventris*** (Crawford), ***Chrysonotomyia*** (*Derostenus*, *Achrysocharella*)  
*rugosithorax* Crawford, *Pediobius* (*Pleurotropis*) = *P. acantha* (Walker)  
***trifasciatus*** Westwood, ***Closterocerus***  
***utahensis*** Crawford, ***Closterocerus***  
*variipes* (Crawford), *Chrysonotomyia* (*Derostenus*, *Achrysocharella*) = *C. formosa* (Westwood)  
*viridis* Provancher, *Chrysocharis* = *C. oscinidis* Ashmead  
***websteri*** (Crawford), ***Diglyphus*** (*Solenotus*)

---

sionary in nature, but rather a means of identifying known *Liriomyza* parasites. Many of the genera treated here are badly in need of work, and there are problems which cannot be resolved without detailed revisionsary studies. It is out of the scope of this paper to attempt to solve all of these problems, however we try to point out problem areas when we are aware of them. The key, discussions, and generic diagnoses are based on females only, and are not intended for general use, only for species reared from *Liriomyza*. Complete revisions of the various genera are referred to in the text and the reader can consult these if there is doubt about species identifications.

Tables which summarize parasite/*Liriomyza* interactions have previously been presented (Minkenberg and van Lenteren 1986, Johnson and Hara 1987), and we have condensed and modified these tables to emphasize the chalcidoid fauna associated with the five most important *Liriomyza* species in North America (Table 2). Records for parasites not determined to species are omitted. Recent reviews of *Liriomyza* contain more complete lists of references to parasite biology, behavior, and effectiveness (Parrella and Robb 1985, Minkenberg and van Lenteren 1986).

## PARASITES

The Chalcidoidea contains 24 species of known parasites of the 5 economically important *Liriomyza* species in the Nearctic region. These are predominantly in the family Eulophidae, with a single Pteromalidae, *Halticoptera circulus* (Walker). The eulophid parasites of *Liriomyza* are in the subfamilies Entedoninae and Eulophinae (tribes Eulophini and Elachertini). Oatman and Kennedy (1976) list a *Tetrastichus* sp. (*Tetrastichinae*), however they do not supply a species name for this parasite.

General host associations and distribution are given for all parasites. This information is taken from catalogues of North American Chalcidoidea (Peck 1963), North

Table 2. Host associations between Nearctic *Liriomyza* species and their parasites condensed from Min-kenberg & van Lentern (1986) and Johnson & Hara (1987).

	<i>brassicae</i>	<i>huidobrensis</i>	<i>trifolicearum</i>
<i>Diglyphus begini</i>	+	+	+
<i>Diglyphus intermedius</i>	+	+	
<i>Diglyphus pulchripes</i>			
<i>Diglyphus websteri</i>			
<i>Pnigalio flavipes</i>			
<i>Chrysocharis ainsliei</i>		+	+
<i>Chrysocharis giraulti</i>			
<i>Chrysocharis crassiscapus</i>	+		
<i>Chrysocharis oscinidis</i>		+	+
<i>Chrysonotomyia diastatae</i>			
<i>Chrysonotomyia formosa</i>			
<i>Chrysonotomyia pictipes</i>	?		
<i>Chrysonotomyia punctiventris</i>	+	+	+
<i>Closterocerus cinctipennis</i>			
<i>Closterocerus trifasciatus</i>			
<i>Closterocerus utahensis</i>			
<i>Pediobius acantha</i>			
<i>Zagrammasoma americanum</i>			
<i>Zagrammasoma lineaticeps</i>			
<i>Zagrammasoma mirum</i>			
<i>Zagrammasoma multilineatum</i>			
<i>Cirrospilus flavoviridis</i>			
<i>Diaulinopsis callichroma</i>	+		
<i>Halticoptera circulus</i>	+	+	+

<sup>a</sup> Oatman & Platner (1969) recorded the species *Derostenus punctipes* Crawford. There is no such species name and it may have been that they meant to refer to this species.

American Hymenoptera (Burks 1979a, b) and revisions of the various genera (which are listed under each genus), and these works should be checked if more complete records are desired. Complete synonymy lists are not given for the genera and species of parasites, although all names used in the literature on *Liriomyza* parasites are given in the text and in Table 1. Complete synonymy lists can be found in the above mentioned catalogues and under the various generic revisions.

**KEY TO SPECIES OF  
LIRIOMYZA PARASITES  
BASED ON FEMALES**

1. Tarsi 5-segmented. Antenna with 6 funicular segments. (Pteromalidae). Notauli complete. Petiole distinct, although may be small. Male with maxillary palpi enlarged, yellow. (genus *Halticoptera*) . . . . . *Halticoptera circulus* (Walker)

- 1'. Tarsi 4-segmented. Antenna with 2-4 funicular segments. (Eulophidae) . . . . . 2
2. Scutellum with 2 setae (1 pair) (Figs. 4-5, 21-22). Submarginal vein with 2 dorsal setae (Figs. 6-8, 11-12). (Entedoninae) . . . . . 3
- 2'. Scutellum with at least 4 setae (2 pairs) (Figs. 42-43). Submarginal vein with more than 2 dorsal setae (Figs. 9-10, 13-18). (Eulophinae) . . . . . 15
3. Propodeum with complete parallel plicae, and two median carina which diverge posteriorly (Fig. 1). (genus *Pediobius*) . . . . . *Pediobius acantha* (Walker)
- 3'. Propodeum without plicae; median carina (if present) not posteriorly bifurcate (Figs. 2-3, 25-28) . . . . . 4
4. Forewing with 2 or 3 distinct, although sometimes faint, transverse bands (Fig. 6). Scape at least slightly flattened and produced ventrally (Figs. 29, 30). Funicle usually slightly to distinctly flattened (Fig. 30). (genus *Closterocerus*) . . . . . 5
- 4'. Forewing without dark bands, at most with a single slightly darkened area beneath stigmal vein. Scape and funicle not flattened . . . . . 7

5. Scape widest subapically, narrowing to apex; funicle and pedicel not or only very slightly flattened (Fig. 29). Mesonotum green . . . . .  
 . . . . . *Closterocerus cinctipennis* Ashmead
- 5'. Scape widest at apex; funicle and pedicel definitely flattened (Fig. 30). Entire body purple to bluish . . . . . 6  
 . . . . . *Closterocerus trifasciatus* Westwood
6. Propodeum distinctly sculptured, with at least some raised, reticulate sculpture medial to spiracle (Fig. 2) . . . . .  
 . . . . . *Closterocerus utahensis* Ashmead
- 6'. Propodeum smooth over entire surface, or with only very faint sculpturing (Fig. 3) . . . . .  
 . . . . . *Closterocerus utahensis* Ashmead
7. Postmarginal vein shorter than the stigmal vein (Figs. 7, 8). Eyes not emarginate. Mesosoma without distinct petiole (Figs. 4, 5). (genus *Chrysonotomyia*) . . . . . 8
- 7'. Postmarginal vein definitely longer (at least 1.5 times) than stigmal vein (Figs. 11, 12). Eyes usually more or less emarginate (Figs. 23, 24). Petiole present and distinct (Figs. 25–28). (genus *Chrysocharis*) . . . . . 10
8. Forewing smoothly rounded apically; slightly more than 2× longer than wide (Fig. 7) . . . . .  
 . . . . . *Chrysonotomyia pictipes* (Crawford)
- 8'. Forewing somewhat truncate apically; slightly less than 2× longer than wide (Fig. 8). . . . . 9
9. Dorsum of mesosoma with uniform, reticulate, distinctly raised sculpture (Fig. 4). Scutellum uniformly colored . . . . .  
 . . . . . *Chrysonotomyia formosa* (Westwood)
- 9'. Dorsum of thorax with at least parts of the scutellum smooth, or with engraved sculpture, or with very weak raised sculpture, but in some way differing from strong, uniform, raised reticulations (Fig. 5). Scutellum with two distinct colors, purple to blue anteriorly, metallic green posteriorly . . . . .  
 . . . . . *Chrysonotomyia diastatae* (Howard)  
 . . . . . *Chrysonotomyia punctiventris* (Crawford)
10. Occiput with a complete sharp, raised carina, which extends the entire width of the vertex (Fig. 19) . . . . . *Chrysocharis liriomyzae* Delucchi
- 10'. Occiput either without carina, or with a carina which is only present medially (Fig. 20) . . . . . 11
11. Longitudinal median groove present in posterior part of mesoscutum and anterior part of scutellum (Fig. 21) . . . . .  
 . . . . . *Chrysocharis crassiscapus* (Thomson)
- 11'. Mesoscutum and scutellum without median longitudinal grooves (Fig. 22) . . . . . 12
12. Petiole more than 2 times longer than wide (Fig. 25) . . . . . *Chrysocharis ignota* Hansson
- 12'. Petiole less than 2 times longer than wide (Figs. 26–28) . . . . . 13
13. Petiole 1.5–1.8 times longer than wide (Fig. 26). Dorsellum (Fig. 26) slightly wider and shorter than that seen in following species (Figs. 27–28) . . . . . *Chrysocharis giraulti* Yoshimoto
- 13'. Petiole 1.0–1.5 times longer than wide (Figs. 27–28). Dorsellum somewhat narrower and longer than in *C. giraulti* . . . . . 14
14. Eyes comparatively larger (Fig. 23). Petiole 1.0–1.5× longer than wide (Fig. 27). Postmarginal vein about 2× longer than stigmal vein (Fig. 11). Hind femora always completely pale yellow . . . . . *Chrysocharis oscinidis* Ashmead
- 14'. Eyes comparatively smaller (Fig. 24). Petiole about as long as wide (Fig. 28). Postmarginal vein often less than 2× longer than stigmal vein (Fig. 12). Hind femora usually dark, rarely completely pale yellow . . . . .  
 . . . . . *Chrysocharis ainsliei* Crawford
15. Notauli incomplete, if traceable to hind margin of mesoscutum then they are indistinct and shallow posteriorly (Fig. 43). (Eulophini) . . . . . 16
- 15'. Notauli complete and distinct, clearly reaching either hind margin of mesoscutum or axillae (Figs. 40–42). (Elachertini) . . . . . 21
16. Antenna with 2 funicular segments (Fig. 31). (genus *Diglyphus*) . . . . . 17
- 16'. Antenna with 4 funicular segments (Fig. 32). (genus *Pnigalio*) . . . . . *Pnigalio flavipes* (Ashmead)
17. Fore wing densely setose, the basal cell uniformly, densely setose (Fig. 13). Stigmal vein and postmarginal vein subequal in length. Antennal scape always dark . . . . . 18
- 17'. Fore wing not so setose, the basal cell not uniformly setose, with at least some areas of sparser setation (Figs. 14–16). Stigmal vein usually shorter than postmarginal vein. Antennal scape either entirely dark, or with basal portion white . . . . . 19
18. Basal 0.25–0.35 of hind tibia with dark metallic coloration, some dusky coloration distally (Fig. 33) . . . . . *Diglyphus intermedius* (Girault)
- 18'. At least 0.75 of hind tibia with dark metallic coloration; coloration not fading distally (Fig. 34) . . . . . *Diglyphus isaea* (Walker)
19. Basal portion of hind tibia with dark, metallic ring less than 0.25 the length of tibia (some dusky coloration may be present past this basal ring) (Figs. 35–36). Antennal scape uniformly dark . . . . . *Diglyphus begini* (Ashmead)  
 . . . . . *Diglyphus carlylei* (Girault)
- 19'. Basal portion of hind tibia with dark, metallic ring at least 0.50 the length of tibia (Fig. 37). Antennal scape white basally . . . . . 20
20. Postmarginal vein always distinctly longer than stigmal vein (Fig. 15) . . . . .  
 . . . . . *Diglyphus websteri* (Crawford)
- 20'. Postmarginal vein at most slightly longer than stigmal vein, usually shorter than stigmal vein;

- stigmal vein somewhat swollen (Fig. 16) . . .  
 . . . . . *Diglyphus pulchripes* (Crawford)
21. Notauli curving to meet axillae, well separated from posterior margin of mesoscutum (Fig. 40). Head vaulted above compound eyes (Fig. 38). (genus *Zagrammosoma*) . . . . . 22
- 21'. Notauli straight, extending to posterior margin of mesoscutum (Fig. 41). Head not so vaulted, not extending distinctly higher than compound eyes (Fig. 39) . . . . . 25
22. Metasoma entirely black (Fig. 44) . . . . . 23
- 22'. Metasoma yellow, although with black markings (Figs. 45–46) . . . . . 24
23. Mesosoma dorsally with wide, median yellow stripe (Fig. 44). Forewing (in addition to other markings) without a dark stripe along apical margin (Fig. 10) . . . . .  
 . . . . . *Zagrammosoma mirum* Girault
- 23'. Mesosoma dorsally black (may have narrow yellow stripe laterally on pronotum). Forewing (in addition to other markings) with a dark stripe along apical margin in posterior half (Fig. 9) . . . . .  
 . . . . . *Zagrammosoma lineaticeps* (Girault)
24. Anterior margin of mesoscutum with dark transverse stripe that is enlarged laterally forming a spot (sometimes concealed beneath posterior margin of pronotum) (Fig. 45) . . .  
 . . . . . *Zagrammosoma multilineatum* (Ashmead)
- 24'. Anterior margin of mesoscutum without transverse stripe (Fig. 46) . . . . .  
 . . . . . *Zagrammosoma americanum* Girault
25. Postmarginal vein much longer (nearly 2×) than stigmal vein (Fig. 17). (genus *Diaulinopsis*). Thorax entirely metallic green . . .  
 . . . . . *Diaulinopsis callichroma* Crawford
- 25'. Postmarginal vein about as long as or shorter than stigmal vein (Fig. 18). (genus *Cirrospilus*). Thorax metallic green with yellow markings . . . . . *Cirrospilus flavoviridis* Crawford

## FAMILY EULOPHIDAE

### SUBFAMILY ENTEDONINAE

#### Genus *Chrysocharis* Förster (Figs. 11–12, 19–28)

Diagnosis.—Scutellum with 2 setae (1 pair); submarginal vein with 2 dorsal setae; propodeum without plicae; wings hyaline; postmarginal vein distinctly longer than stigmal vein; petiole present and distinct, usually at least as long as wide; eyes usually slightly emarginate.

Discussion.—Nearctic species of the ge-

nus *Chrysocharis* revised by Hansson (1987), who provided a key to species, and host and distribution information. A separate paper (Hansson 1985) treats Palaearctic members of this genus. Species of *Chrysocharis* are, with a few exceptions, primary, solitary, endoparasites of larvae and pupae of leaf-mining insects. Most are polyphagous, with an extremely wide host range. For complete host and distribution lists, see Hansson (1987), Burks (1979b), Peck (1963).

#### *Chrysocharis ainsliei* Crawford (Figs. 12, 24, 28)

This species and *C. oscinidis* (= *parksii*, *viridis*) are distinguished from the other *Chrysocharis* species because they lack the distinct, complete carina on the vertex, lack the longitudinal, median grooves on the mesoscutum and scutellum, have the petiole 1.0–1.5 times longer than wide, and the dorsellum slightly longer and narrower than that seen in *C. giraulti*. This species is variable, and difficult to distinguish from *C. oscinidis*. *Chrysocharis oscinidis* has completely pale hind femora, and *ainsliei* has previously been separated from *oscinidis* as it has dark hind femora. However, Hansson (1987) has shown that this character is variable, and specimens of *ainsliei* with pale hind femora are known. Apparently the only valid characters for separating these two species are those given by Hansson (1987) and repeated in the key in this paper: the eyes are somewhat larger in *oscinidis* than in *ainsliei*; the petiole in *ainsliei* is about as long as wide, in *oscinidis* it ranges from 1.0–1.5× as long as wide; the postmarginal vein in *ainsliei* is often less than 2× longer than the stigmal vein, in *oscinidis* it is always about 2× longer than the stigmal vein.

Distribution.—Widely distributed and common throughout the Nearctic region. Also known from Cuba, Guam, Hawaii, and Europe.

Hosts.—Larval-pupal parasite of leaf-mining Agromyzidae.

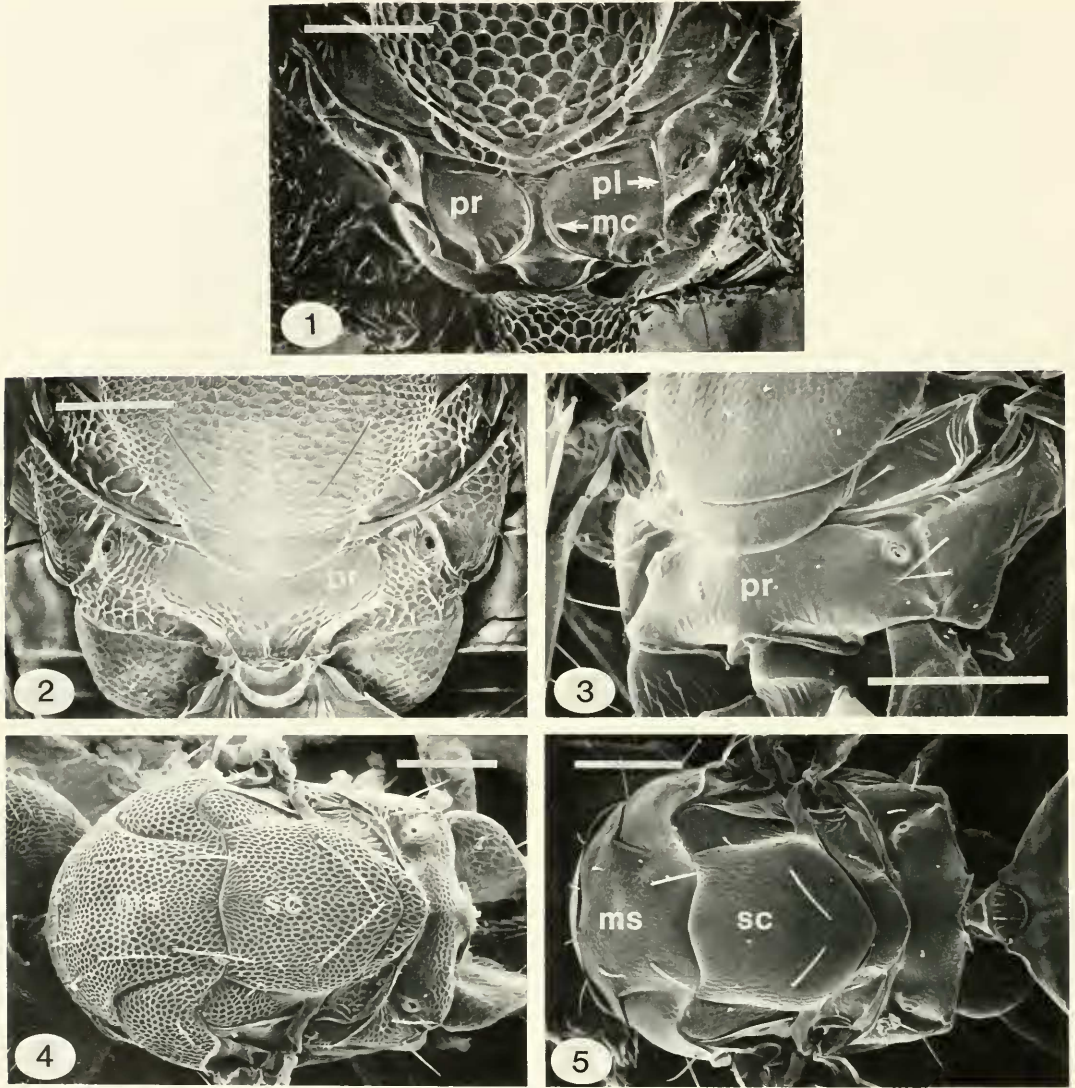


Plate 1. (Figs. 1–5). 1. *Pedibius acantha*, ♀, propodeum. 2. *Closterocerus trifasciatus*, ♀, propodeum. 3. *Closterocerus utahensis*, ♀, propodeum. 4. *Chrysonotomyia formosa*, ♀, mesosoma. 5. *Chrysonotomyia diastatae*, ♀, mesosoma. Scale bars = 0.1 mm. mc = median carina; ms = mesoscutum; pl = plica; pr = propodeum; sc = scutellum.

*Chrysocharis crassiscapus* (Thomson)  
(Fig. 21)

This species has also been treated under the name *C. mallochi* Gahan. It can be distinguished from the other *Chrysocharis* species due to the longitudinal median groove present on the posterior part of the meso-

scutum and the anterior part of the scutellum (Fig. 21).

Distribution.—Wide distribution through Eastern USA, and throughout Canada and Alaska. Also known from Europe.

Hosts.—Leaf- and stem-mining Agromyzidae.

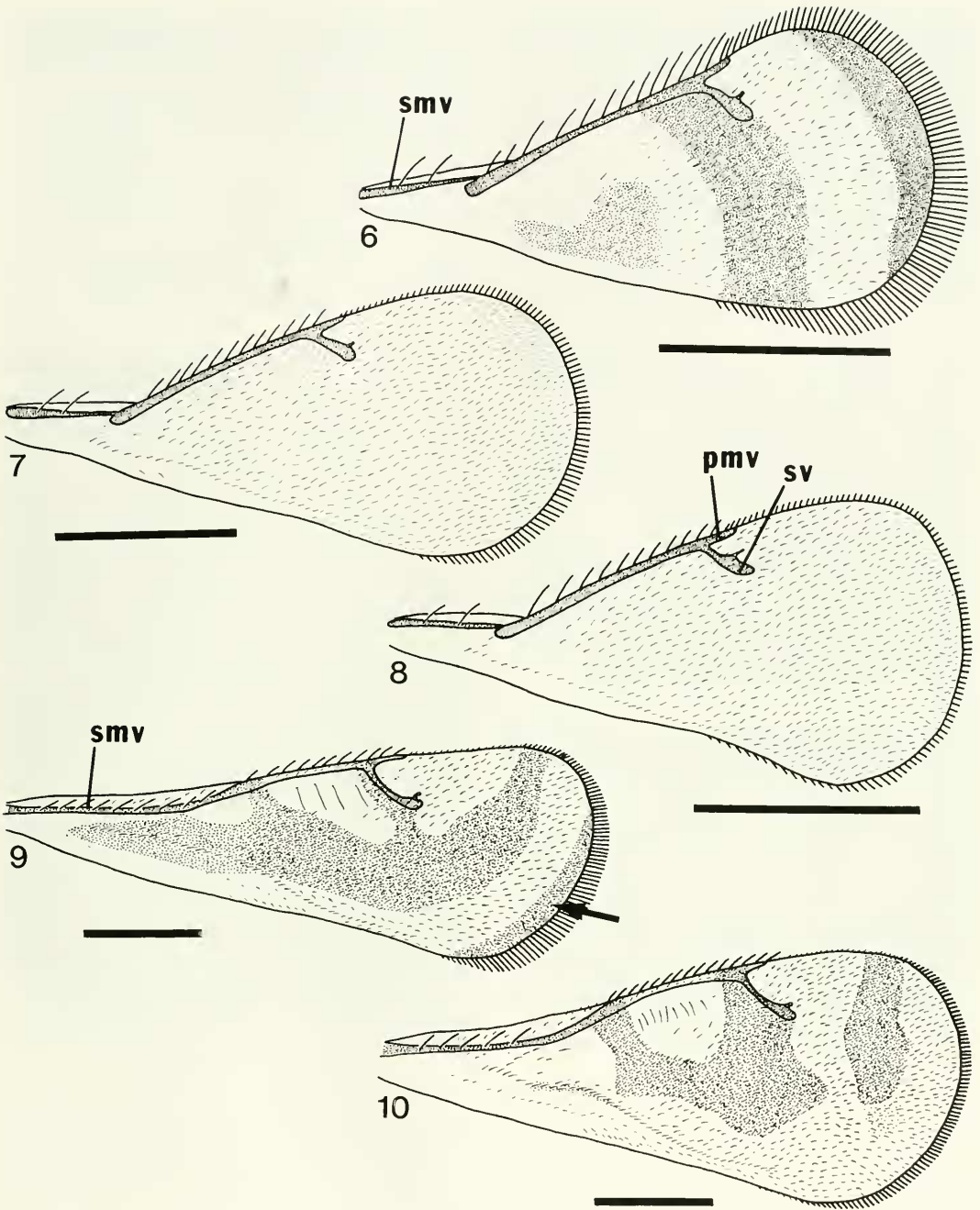


Plate 2. (Figs. 6–10). Female forewings. 6. *Closterocerus utahensis*. 7. *Chrysonotomyia pictipes*. 8. *Chrysonotomyia diastatae*. 9. *Zagrammosoma lineaticeps*. 10. *Zagrammosoma mirum*. Scale bars = 0.3 mm. pmv = postmarginal vein; smv = submarginal vein; sv = stigmal vein.

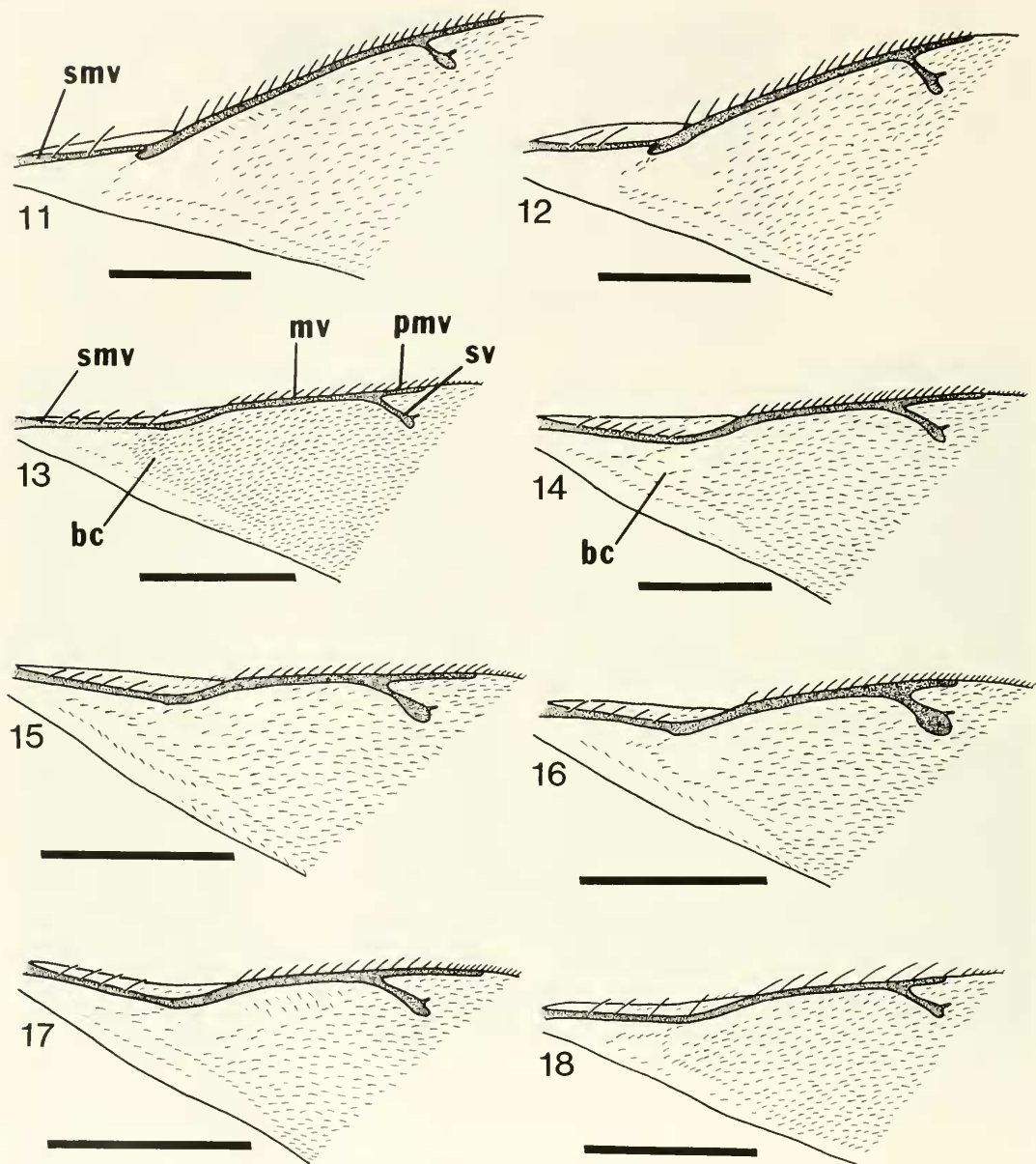


Plate 3. (Figs. 11-18). Female forewing venation. 11. *Chrysocharis oscinidis*. 12. *Chrysocharis ainsliei*. 13. *Diglyphus intermedius*. 14. *Diglyphus begini*. 15. *Diglyphus websteri*. 16. *Diglyphus pulchripes*. 17. *Diaulinopsis callichroma*. 18. *Cirrospilus flavoviridis*. Scale bars = 0.3 mm. bc = basal cell; mv = marginal vein; pmv = postmarginal vein; smv = submarginal vein; sv = stigmal vein.

*Chrysocharis giraulti* Yoshimoto  
(Fig. 26)

This species has also been treated as *C. petiolata* Girault. It is distinguished from

the other *Chrysocharis* species because it lacks the distinct, complete carina on the vertex, lack the longitudinal, median grooves on the mesoscutum and scutellum, the petiole is 1.5-1.8 times longer than wide, and



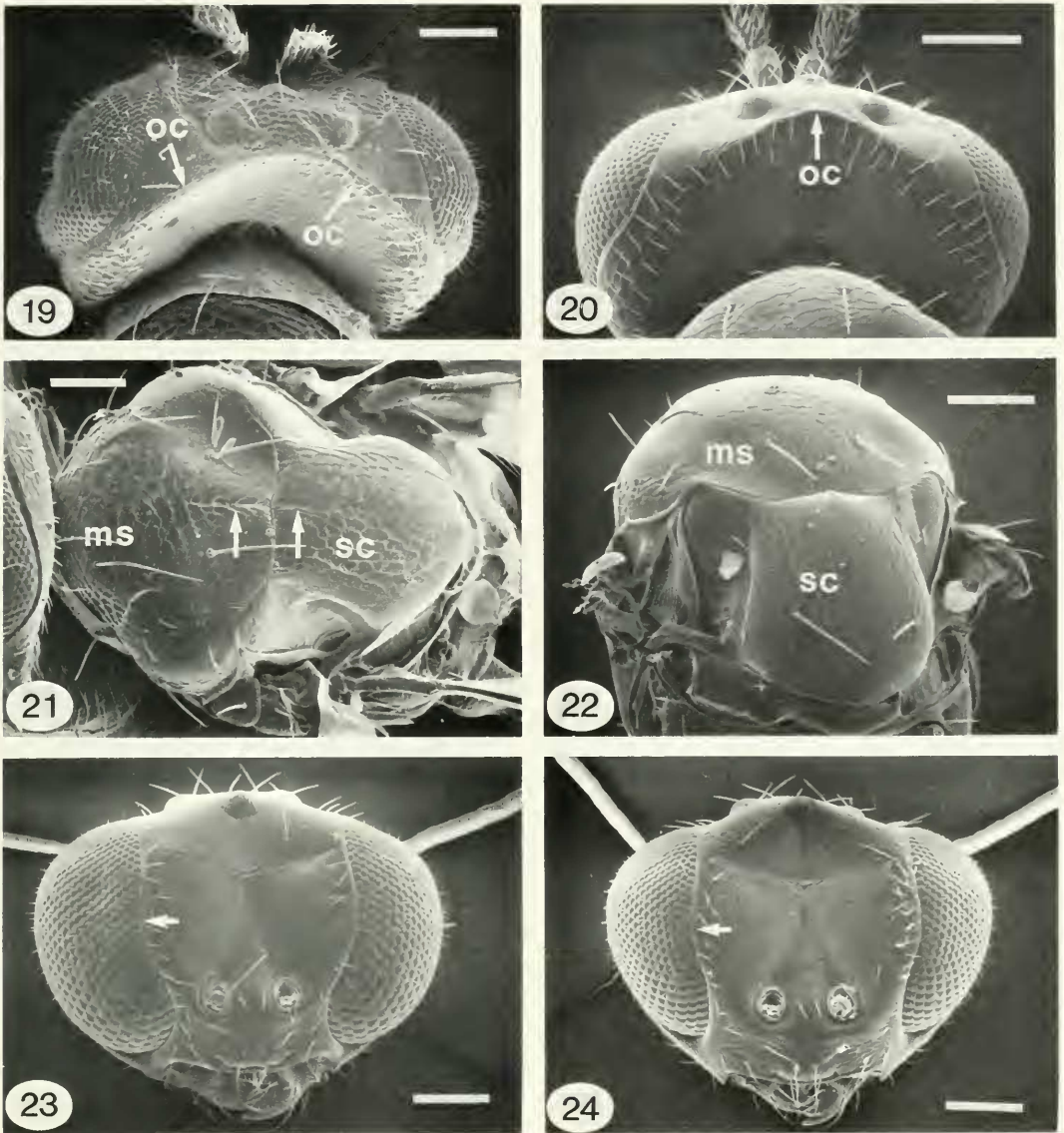


Plate 4. (Figs. 19–24). *Chrysocharis* spp. 19. *C. liriomyzae*, occiput. 20. *C. oscinidis*, occiput. 21. *C. crassiscapus*, mesosoma. 22. *C. oscinidis*, mesosoma. 23. *C. oscinidis*, head. 24. *C. ainsliei*, head. Scale bars = 0.1 mm. ms = mesoscutum; oc = occipital carina; sc = scutellum.

the dorsellum is slightly wider and shorter than that seen in other species.

**Distribution.**—Widespread in USA from Arizona to New York (absent in the extreme Southeast and Pacific Coast), throughout Canada and Alaska.

**Hosts.**—Leafmining Agromyzidae on herbs.

*Chrysocharis ignota* Hansson  
(Fig. 25)

This species is distinguished from other *Chrysocharis* species because it lacks the

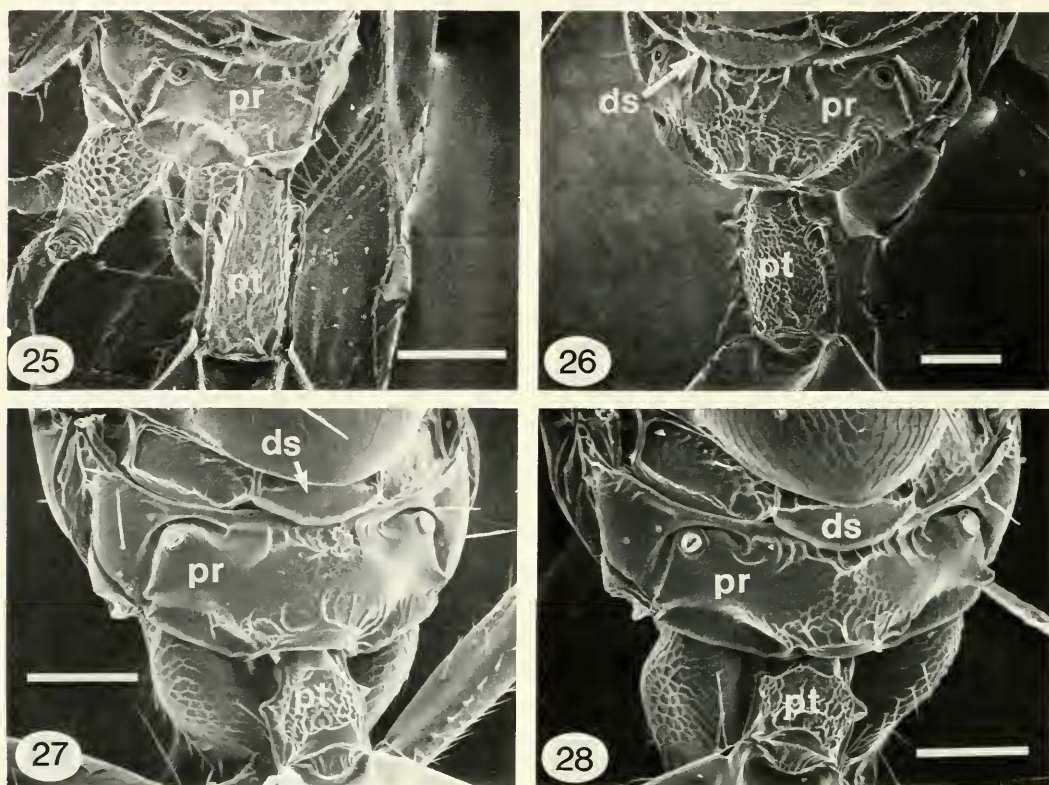


Plate 5. (Figs. 25–28). *Chrysocharis* spp., ♀, petioles. 25. *C. ignota*. 26. *C. giraulti*. 27. *C. oscinidis*. 28. *C. ainsliei*. Scale bars = 0.1 mm. ds = dorsellum; pr = propodeum; pt = petiole.

distinct, complete carina on the vertex, lacks the longitudinal, median grooves on the mesoscutum and scutellum, and the petiole is at least 2.0 times longer than wide. This species was recently described by Hansson (1987) who, recorded it from *Liriomyza* sp. mining herbs. It is included, even though the exact host species of *Liriomyza* is yet unknown.

Distribution.—USA, Canada. Also Central America and northern South America.  
Hosts.—From *Liriomyza* sp. on herbs.

*Chrysocharis liriomyzae* Delucchi  
(Fig. 19)

This species has also been treated as *C. punctifacies* Delucchi. It is distinguished

from the other *Chrysocharis* species by the strong, sharp, complete occipital carina which extends from the vertex all the way onto the gena (Fig. 19). This species was introduced into North America as a parasite of *Agromyza frontella* (Rondani), with subsequent establishment (Hendrickson and Barth 1979, as *C. punctifacies*). This is the only known Nearctic host, although it is known to attack *Liriomyza* species including *L. trifolii* in Europe (Boucek and Askew 1968), and it is likely that it will attack *Liriomyza* in North America.

Distribution.—Palearctic; introduced into eastern United States, with subsequent recovery (Hendrickson and Barth 1979, as *C. punctifacies*).

Hosts.—Leafmining Agromyzidae on herbs. For a complete list of hosts in Europe see Boucek and Askew (1968).

*Chrysocharis oscinidis* Ashmead  
(Figs. 11, 20, 22, 23, 27)

The species has previously been treated in the literature as *C. parksi* and *C. viridis*. It is extremely close to *C. ainsliei*, and is discussed under that species. A recent biological study has been done on this parasite on *L. trifolii* (Christie and Parrella 1987, as *C. parksi*).

Distribution.—Wide distribution throughout the Nearctic region.

Hosts.—Leafmining Agromyzidae on herbs, shrubs and trees.

Genus *Chrysonotomyia* Ashmead  
(Figs. 4–5, 7–8)

Diagnosis.—Scutellum with 2 setae (1 pair); submarginal vein with two dorsal setae; propodeum without plicae; wings hyaline, or with only a single faint infuscated area posterior to stigmal vein; postmarginal vein shorter than (at most as long as) stigmal vein; metasoma sessile, not definitely petiolate; eyes not emarginate.

Discussion.—The genus *Chrysonotomyia* and its relatives (*Achrysocharis* Girault, *Achrysocharella* Girault and *Neochrysocharis* Kurdjumov) are badly in need of systematic revision. *Neochrysocharis*, *Achrysocharella* and *Achrysocharis* have been treated as distinct genera by European authors (Graham 1959, Peck et al. 1964, Boucek and Askew 1968), however in two of these cases (Peck et al., Boucek and Askew) it was noted that these genera were probably synonymous. Yoshimoto (1978) placed *Achrysocharis* and *Achrysocharella* in synonymy with *Chrysonotomyia* (*Achrysocharella* as a subgenus), but did not mention *Neochrysocharis*. Burks (1979b) treated all four of these as separate genera. Recently, Boucek (1988) treated *Neochrysocharis*,

*Achrysocharis* and *Achrysocharella* as synonyms of *Chrysonotomyia*. This is the classification we are following in this paper, although since then Hansson (1990) treated European species of *Chrysonotomyia* and *Neochrysocharis*, which he considered as separate genera, and provided a key for the separation of these two genera.

The Nearctic *Liriomyza* parasites in this genus have previously been treated in the literature predominantly under the generic names *Achrysocharella* and *Derostenus*. The genus *Derostenus* is not closely related to *Chrysonotomyia*, but it was previously misunderstood by North American workers, with the result that many species of *Chrysonotomyia* were described in it.

Yoshimoto (1978) revised the Nearctic species of *Chrysonotomyia*, subgenus *Achrysocharella*, and provided a key to species (which included *diastatae*, *punctiventris* and *formosa*, but not *pictipes*). Despite this revision, there are still several problems, and *Chrysonotomyia* is in need of further work. We are following the specific synonymies given by Yoshimoto, however preliminary indications are that some of these synonymies may not be correct, and these cases are discussed in the text under the individual species.

Members of *Chrysonotomyia* are parasites of leafmining, leafrolling and leaf-tying *Lepidoptera*, and leafmining *Diptera*, *Hymenoptera* and *Coleoptera*, as well as other phytophagous insects including Cecidomyiidae and Cynipidae. For complete host and distribution information see Yoshimoto (1978), Peck (1963), Burks (1979b), Boucek (1988) and Hansson (1990).

*Chrysonotomyia diastatae* (Howard)  
(Figs. 5, 8)

*Chrysonotomyia diastatae* and *C. punctiventris* are keyed out together because they appear very closely related. Examination of type material indicates that it may not be

possible to separate these species based on the characters given by Yoshimoto (1978), and more detailed study may show them to be synonymous. They may be distinguished from the other *Chrysonotomyia* species because they do not have the distinct, uniform, raised reticulate sculpture on the dorsum of the mesosoma or a light infuscated area posterior to the stigmal vein as seen in *formosa*; the wing is somewhat truncate apically and slightly less than  $2\times$  longer than wide; and the scutellum is distinctly two colored, purple to blue anteriorly and green posteriorly.

Distribution.—Wide distribution throughout the Nearctic region.

Hosts.—Diptera (Agromyzidae, Diastidae).

*Chrysonotomyia formosa* (Westwood)  
(Fig. 4)

This species has also been treated in the leafminer literature under the names *Achrysocharella formosa*, *Derostenus variipes*, *A. variipes*, and *D. fullawayi*. It is distinguished from the other species of *Chrysonotomyia* by the distinct, uniform, raised reticulate sculpture on the dorsum of the mesosoma; and the forewing has a slight infuscated area immediately posterior to the stigmal vein. This species is considered important in regulating populations of *L. trifolii* and *L. sativae* in vegetable crops (Lema and Poe 1978).

Distribution.—Wide distribution in the Nearctic, also known from Europe, Africa and Hawaii.

Hosts.—Several species of Lepidoptera, Diptera, Hymenoptera and Coleoptera.

*Chrysonotomyia pictipes* (Crawford)  
(Fig. 7)

This species has also been treated under the name *Derostenus pictipes*. It is distinguished from the other species of *Chrysonotomyia* because it lacks the distinct, uniform, raised reticulated sculpture on the

dorsum of the mesosoma, and the slight infuscated area posterior to the stigmal vein as seen in *formosa*; the forewing is fairly uniformly rounded apically and slightly more than  $2\times$  longer than wide; and the scutellum is uniformly green.

Distribution.—United States, from Colorado and Utah to the East Coast.

Hosts.—Agromyzidae.

*Chrysonotomyia punctiventris*  
(Crawford)

This species has also been treated in the literature under the names *Derostenus punctiventris*, *D. arizonensis*, and *D. agromyzae*. It is very similar to *diastatae*, and is discussed under that species. One of the species that Yoshimoto (1978) placed under synonymy with *punctiventris*, *C. agromyzae* (Crawford), appears not to be this species, but actually closer to, if not synonymous with, *C. pictipes*.

Distribution.—Wide distribution throughout the United States, also known from Guatemala and Hawaii.

Hosts.—Agromyzidae.

Genus *Closterocerus* Westwood  
(Figs. 2–3, 6, 29–30)

Diagnosis.—Scutellum with 2 setae (1 pair); submarginal vein with 2 dorsal setae; propodeum without plicae; wings with 2 or 3 dark transverse bands; funicular segments and pedicel slightly to distinctly flattened.

Discussion.—Crawford (1912) provided a key to the four species of *Closterocerus* known from North America at that time, however this group has not been treated since then and it badly needs revision at the specific level.

Species of *Closterocerus* are mainly parasites of leafmining Coleoptera, Lepidoptera, Hymenoptera and Diptera. Complete host and distribution lists are given in Peck (1963) and Burks (1979b).

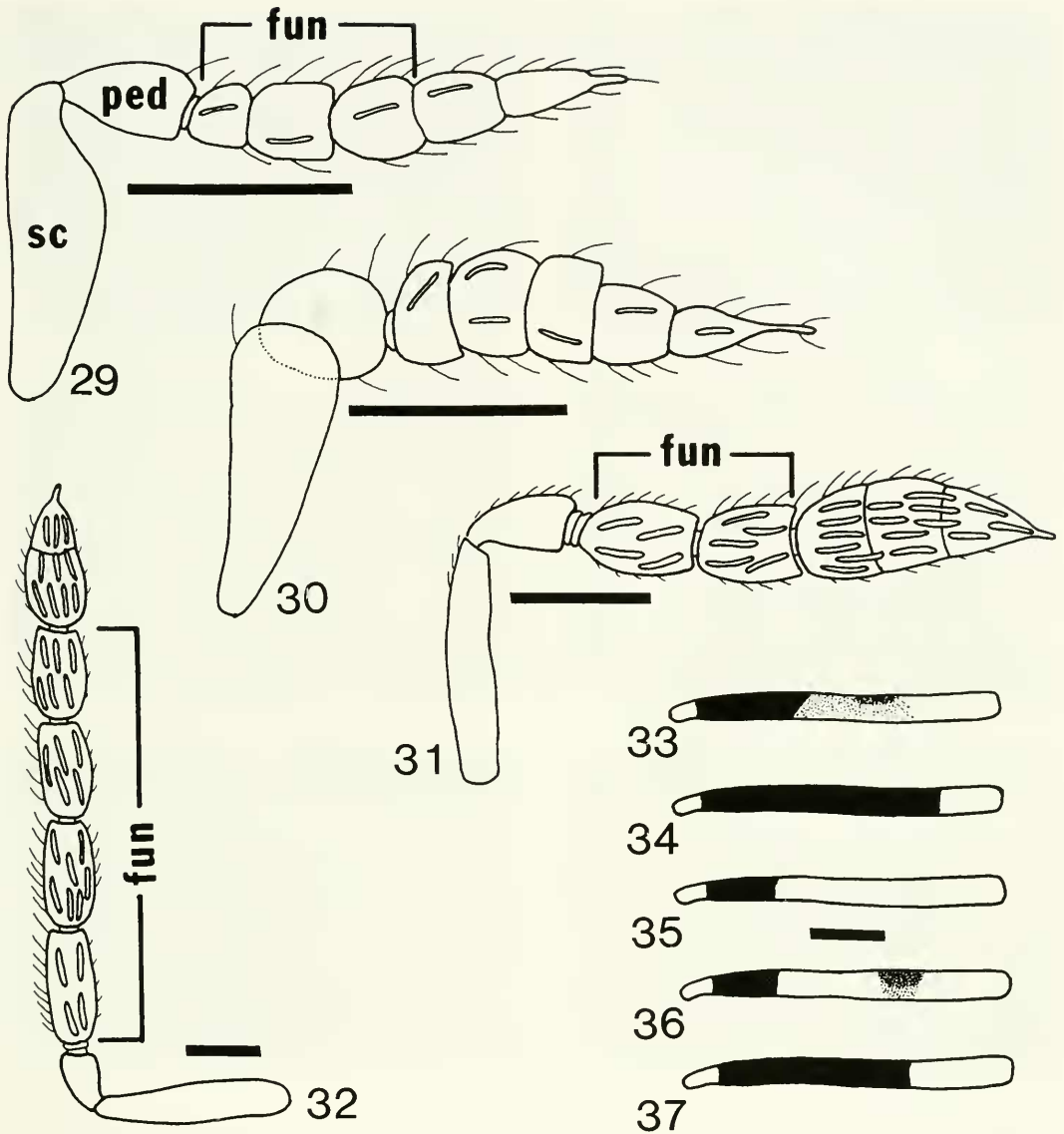


Plate 6. (Figs. 29–37). 29. *Closterocerus cincitipennis*, ♀, antenna. 30. *Closterocerus utahensis*, ♀, antenna. 31. *Diglyphus intermedius*, ♀, antenna. 32. *Pnigalio flavipes*, ♀, antenna. 33. *Diglyphus intermedius*, ♀, hind tibia. 34. *Diglyphus isaea*, ♀, hind tibia. 35. *Diglyphus begini*, ♀, hind tibia. 36. *Diglyphus carlylei*, ♀, hind tibia. 37. *Diglyphus websteri*, ♀, hind tibia. Scale bars = 0.1 mm. fun = funicle; ped = pedicel; sc = scape.

*Closterocerus cincitipennis* Ashmead  
(Fig. 29)

*Closterocerus cincitipennis* can be distinguished from the other *Closterocerus* species due to the following characters: propodeum

smooth or only very lightly sculptured; scape widest subapically, tapering apically; funicle and pedicel not distinctly flattened, only slightly if at all flattened; mesonotum green. There are only two transverse bands on the forewing.

Distribution.—Predominantly Eastern North American from Quebec to Florida.

Hosts.—Leafmining Coleoptera, Lepidoptera, Hymenoptera and Diptera.

*Closterocerus trifasciatus* Westwood  
(Fig. 2)

*Closterocerus trifasciatus* can be distinguished from the other *Closterocerus* species because it has distinct, raised sculpture on the propodeum, at least in the area just median to the spiracle. The funicle and pedicel are distinctly flattened, and there are three transverse bands on the forewing, although the proximal one may be weak.

Distribution.—Wide range throughout the United States; also Europe.

Hosts.—*Liriomyza sativae* is the only recorded host from North America, although it has been recorded in Europe from a variety of hosts in the Coleoptera, Lepidoptera, Hymenoptera and Diptera (see Boucek and Askew 1968, for a complete list).

*Closterocerus utahensis* Crawford  
(Fig. 3, 6, 30)

*Closterocerus utahensis* can be distinguished from the other *Closterocerus* species by the following characters: propodeum smooth, or only very lightly sculptured; scape widest at apex; funicle and pedicel distinctly flattened; entire body blue to purple. There are two transverse bands on the forewing, and a faint, complete to partial third band may be present proximal to the other two.

Distribution.—Wide range throughout the United States.

Hosts.—Leafmining Lepidoptera, Diptera and Hymenoptera.

Genus *Pediobius* Walker  
(Fig. 1)

Diagnosis.—Scutellum with 2 setae (1 pair); submarginal vein with 2 dorsal setae; propodeum with complete parallel plicae, and two median carinae which diverge posteriorly.

Discussion.—The only member of this genus which is known from a *Liriomyza* species has also been treated under the generic name *Pleurotropis*. Nearctic species of *Pediobius* were revised Peck (1985), who provided a key to species and host and distribution information (mainly Canadian and Alaskan records). Burks (1966) had an earlier revision of this genus, and provided host and distribution information throughout North America. Boucek (1965) revised the Palaearctic members of this genus. Members of the genus *Pediobius* are primary or secondary parasites on a wide range of hosts. Many are parasitic on lepidopterous, dipterous and coleopterous leafminers, however only a single Nearctic species, *P. acantha*, is known to attack *Liriomyza*.

*Pediobius acantha* (Walker)  
(Fig. 1)

This species has been treated in the literature under the names *Pleurotropis rugosithorax* and *Pediobius rugosithorax*. This is the only Nearctic species of *Pediobius* known to parasitize *Liriomyza*.

Distribution.—Midwestern USA, and throughout southern Canada; also Europe, Iraq, Pakistan, India, Korea.

Hosts.—Agromyzidae: *Liriomyza* sp., *Phytobia angulata* (Loew), *Phytagromyza populicola* (Walker).

FAMILY EULOPHIDAE  
SUBFAMILY EULOPHINAE  
(Tribe EULOPHINI)

Genus *Diglyphus* Walker  
(Figs. 13–16, 31, 33–37, 43)

Diagnosis.—Scutellum with 4 setae (2 pairs); submarginal vein with more than 2 dorsal setae; notauli incomplete; funicle 2-segmented.

Discussion.—Species in this genus have often been treated in the literature under the generic names *Diaulinus* and *Solenotus*. The Nearctic and Neotropical species of *Di-*

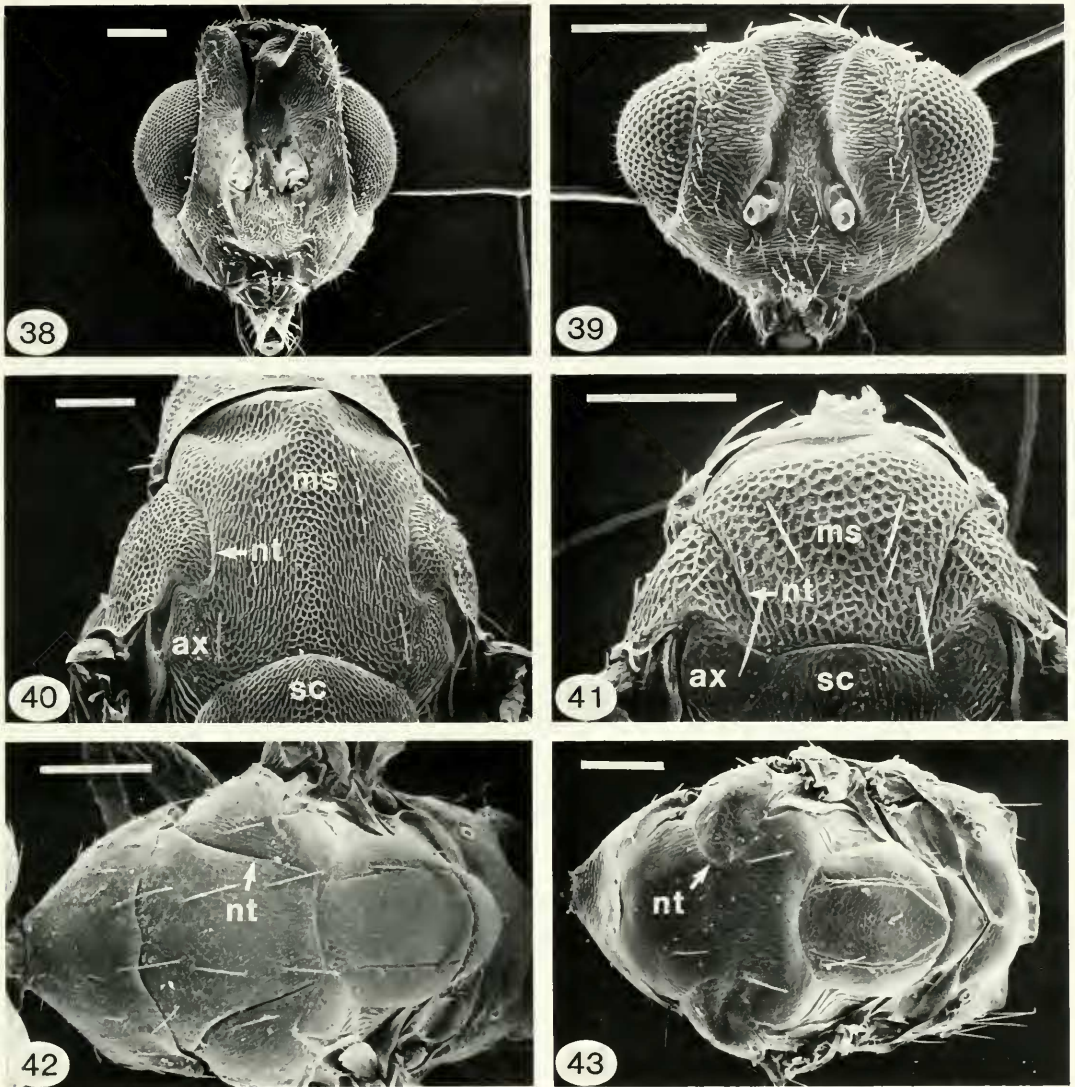


Plate 7. (Figs. 38–43). 38. *Zagrammosoma mirum*, ♀, head. 39. *Cirrospilus flavoviridis*, ♀, head. 40. *Zagrammosoma mirum*, ♀, mesosoma. 41. *Cirrospilus flavoviridis*, ♀, mesosoma. 42. *Diaulinopsis callichroma*, ♀, mesosoma. 43. *Diglyphus intermedius*, ♀, mesosoma. Scale bars = 0.1 mm. ax = axilla; ms = mesoscutum; nt = notaulus; sc = scutellum.

*glyphus* were revised by Gordh and Hendrickson (1979) who presented a key to species, and host and distribution information.

*Diglyphus* species are solitary ectoparasites of leafmining Diptera (Agromyzidae) and Lepidoptera (Lithocolletidae and Lyonetiidae). Further information on hosts and

distribution can be found in Gordh and Hendrickson (1979), Peck (1963) and Burks (1979b). This genus is important in regulating populations of *Liriomyza* in the field (through natural migration) and greenhouse (through innoculative or inundative releases).

*Diglyphus begini* (Ashmead)  
(Figs. 14, 35)

This species has also been treated in the literature under the names *Diaulinus begini* and *Solenotus begini*. It can be distinguished from the other *Diglyphus* species because the basal area of the forewing is not uniformly and densely setose; the basal ring of dark metallic color on the middle and hind tibiae is less than 0.25 the length of the tibia; and the scape is uniformly dark metallic in color.

*Diglyphus carlylei* is morphologically very similar to *begini*, the only difference being that *carlylei* has some dusky coloration on the middle and hind tibiae distal to the basal ring (Fig. 36), and *begini*, does not have any dusky coloration distal to the basal ring (Fig. 35). Gordh and Hendrickson (1979) have pointed out that *carlylei* may represent nothing more than a color variant of *begini*, and we agree with them that it will require biological studies to determine whether these are one species or two. A thorough biological study of *D. begini* has recently been completed (Heinz and Parrella 1990).

Distribution.—Throughout the Nearctic region, although it is numerically more important in the western United States and Canada.

Hosts.—Several species of Agromyzidae.

*Diglyphus carlylei* (Girault)  
(Fig. 36)

*D. carlylei* has not been reared as a parasite of *Liriomyza*, however since it is extremely close morphologically to *begini* it is included here, and discussed further under *begini*.

Distribution.—California.

Hosts.—Unknown.

*Diglyphus intermedius* (Girault)  
(Figs. 13, 31, 33, 43)

This species has also been treated in the literature under the name *Solenotus intermedius*. *Diglyphus intermedius* and *isaea* can be distinguished from the other species of

*Diglyphus* because the basal area of the forewing is uniformly and densely setose (without any bare areas); the stigmal and post-marginal veins are approximately equal in length; and the antennal scape is entirely dark metallic in color. These two species are distinguished from each other because in *intermedius* the basal ring of dark metallic color on the hind tibia only extends 0.25–0.35 the length of the tibia, and in *isaea* the basal ring covers the entire tibia except the extreme apex. *Diglyphus intermedius* can occasionally have additional dusky coloration on the hind tibia, however this will not be as dark as the basal ring, and it will usually be separated from the basal ring by a light colored area.

Distribution.—Throughout the United States.

Hosts.—Several species of Agromyzidae.

*Diglyphus isaea* (Walker)  
(Fig. 34)

Distinguishing characteristics of *D. isaea* are discussed under *intermedius*. This European species is included because it has been released in large numbers against *Agromyza frontella* (Rondani) on the East Coast of the United States with the possibility of some interbreeding with *D. intermedius* (Hendrickson and Barth 1979, Gordh and Hendrickson 1979). It attacks several species of *Liriomyza* (including *L. trifolii*) in Europe. Recent studies (Malais et al., unpublished data) have found this parasite attacking *L. huidobrensis* in California.

Distribution.—Throughout the Palearctic region; Eastern United States, California.

Hosts.—Many species of Agromyzidae; also Lepidoptera (Lyontiidae). For complete host list see Boucek and Askew (1968).

*Diglyphus pulchripes* (Crawford)  
(Fig. 16)

This species has also been treated in the literature under the name *Solenotus pulchripes*. It can be distinguished from the other species of *Diglyphus* because of the basal



cell of the forewing is not uniformly and densely setose; the basal ring of the dark metallic color on the hind tibia is at least 0.5 the length of the tibia; the scape is white basally; and the postmarginal vein is at most slightly longer than the stigmal vein, sometimes shorter.

Distribution.—Eastern United States and Canada.

Hosts.—Several species of Agromyzidae.

*Diglyphus websteri* (Crawford)  
(Figs. 15, 37)

This species has also been treated in the literature under the names *Diaulinus websteri* and *Solenotus websteri*. It can be distinguished from the other species of *Diglyphus* because the basal cell of the forewing is not uniformly and densely setose; the basal ring of dark metallic color on the hind tibia is at least 0.5 the length of the tibia; the scape is white basally; and the postmarginal vein is distinctly longer than the stigmal vein.

Distribution.—Throughout the United States.

Hosts.—Several species of Agromyzidae.

Genus *Pnigalio* Schrank  
(Fig. 32)

Diagnosis.—Scutellum with 4 setae (2 pairs); submarginal vein with several (more than 2) dorsal setae; postmarginal vein long; notauli incomplete; antenna with 4 funicular segments, the fourth distinctly longer than wide; propodeum with plicae, median carina and costula well-developed.

Discussion.—Nearctic species of *Pnigalio* were revised by Miller (1970), who provided a key to species, and host and distribution information. Species of *Pnigalio* are parasitic on leafmining insects, mostly Lepidoptera, but also Coleoptera, Hymenoptera and Diptera. Most species are extremely polyphagous. Only a single Nearctic species, *P. flavipes*, is known to attack *Liriomyza*.

*Pnigalio flavipes* (Ashmead)  
(Fig. 32)

This is the only Nearctic species of *Pnigalio* that is known to parasitize *Liriomyza*.

Distribution.—General distribution across southern Canada and northern United States, although specimens are known from as far south as Texas. Complete distribution is given by Miller (1970).

Hosts.—Miller (1970) gives a long list of hosts for this species, which are mainly insects which form blotch or tentiform mines on deciduous plants. Hosts are known from Lepidoptera, Hymenoptera, Coleoptera and Diptera.

FAMILY EULOPHIDAE  
SUBFAMILY EULOPHINAE  
(Tribe ELACHERINI)

Genus *Zagrammosoma* Ashmead  
(Figs. 9–10, 38, 40, 44–46)

Diagnosis.—Scutellum with 4 setae (2 pairs); submarginal vein with more than 2 dorsal setae; notauli complete, curving to meet axilla at a distance well separated from posterior margin of mesoscutum; funicle 2-segmented; head with vertex vaulted between compound eyes.

Discussion.—The Nearctic species of *Zagrammosoma* were revised by Gordh (1978), who provided a key to species, and host and distribution information. Species in this genus are parasitic on leafmining Lepidoptera and Diptera. The genus *Mirzagrammosoma* has recently been synonymized with *Zagrammosoma* (LaSalle 1989), and the only included species *M. lineaticeps* has been transferred to *Zagrammosoma* and is treated as such in this paper. Additional information on hosts, distribution, and synonymies can be found in Gordh (1978), Peck (1963) and Burks (1979b).

*Zagrammosoma americanum* Girault  
(Fig. 45)

*Zagrammosoma americanum* is distinguished from the other *Zagrammosoma*

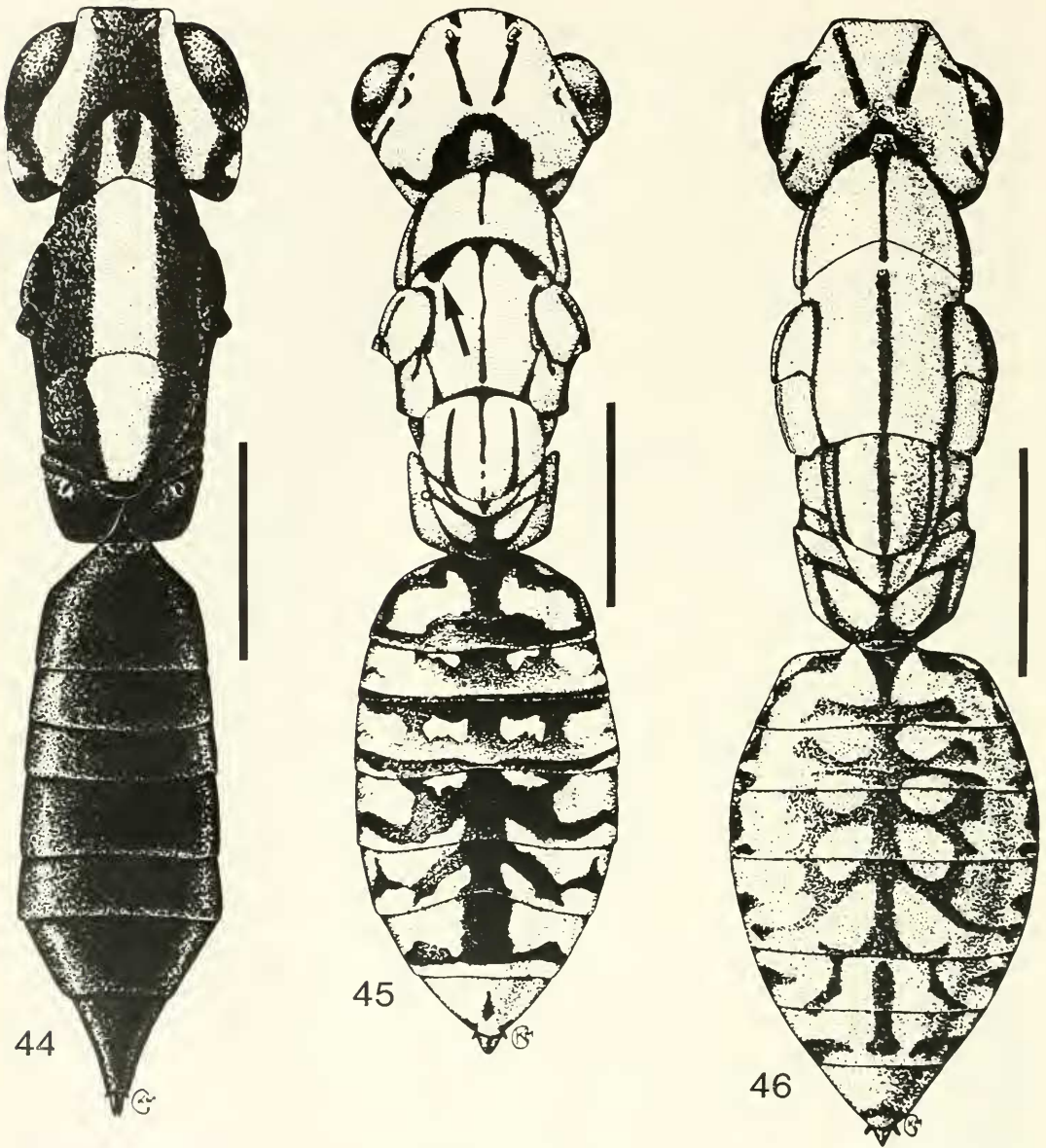


Plate 8. (Figs. 44–46). *Zagrammosoma*, ♀, bodies (from Gordh 1978). 44. *Z. mirum*. 45. *Z. americanum*. 46. *Z. multilineatum*. Scale bars = 0.4 mm.

species because the metasoma is predominantly yellow, although with extensive black markings; and the anterior margin of the mesoscutum has a dark, transverse stripe that is enlarged laterally to form a spot (although this may be partially concealed by the pronotum).

Distribution.—Southwestern United States.

Hosts.—Agromyzidae (*Liriomyza*) and Gelechiidae (Coleotechnites).

*Zagrammosoma lineaticeps* (Girault)  
(Fig. 9)

This species has also been treated under the name *Mirzagrammosoma lineaticeps*. It is distinguished from the other *Zagrammosoma* species because the metasoma is

entirely black or very dark; the dorsum of the mesosoma is predominantly black, with a few small lines, but without a wide, longitudinal, medial yellow stripe; and the wing (in addition to other markings) has a dark stripe along the apical margin in the posterior half.

Distribution.—Florida, Texas, California; also Mexico, Central America and Caribbean.

Hosts.—Agromyzidae (*Liriomyza*) and Lepidoptera (Lyontiidae, Gelechiidae).

*Zagrammasoma mirum* Girault  
(Figs. 10, 38, 40, 44)

*Zagrammosoma mirum* is distinguished from the other *Zagrammasoma* species because the metasoma is entirely black or very dark; the dorsum of the mesosoma is predominantly black with a wide, longitudinal, medial yellow stripe; and the wing (in addition to other markings) has no dark markings along the apical margin.

Distribution.—California.

Hosts.—Agromyzidae (*Liriomyza*) and Gracillariidae (*Lithocolletis*).

*Zagrammosoma multilineatum*  
(Ashmead)  
(Fig. 46)

*Zagrammosoma multilineatum* is distinguished from the other *Zagrammosoma* species because the metasoma is predominantly yellow, although with extensive black markings; and the anterior margin of the mesoscutum has no dark, transverse stripe or lateral spot.

Distribution.—Throughout eastern United States.

Hosts.—Lepidoptera (Gracillariidae and Tischeridae) and Diptera (Agromyzidae).

Genus *Cirrospilus* Westwood  
(Figs. 18, 39, 41)

Diagnosis.—Scutellum with 4 setae (2 pairs); submarginal vein with several (more than 2) dorsal setae; notauli complete, straight, extending to posterior margin of mesoscutum; antenna with 2 funicular seg-

ments; postmarginal vein about as long as stigmal vein.

Discussion.—There has not been a recent generic revision of Nearctic members of the genus *Cirrospilus*. Members are usually solitary ectoparasites of leafmining Lepidoptera, Hymenoptera and Diptera. There is a single species, *C. flavoviridis*, known to attack *Liriomyza*. Further information on host, distribution and synonymies can be found in Peck (1963) and Burks (1979b).

*Cirrospilus flavoviridis* Crawford  
(Figs. 18, 39, 41)

This is the only Nearctic species of *Cirrospilus* that is known to parasitize *Liriomyza*.

Distribution.—Western United States.

Hosts.—Several species of Agromyzidae.

Genus *Diaulinopsis* Crawford  
(Figs. 17, 42)

Diagnosis.—Scutellum with 4 setae (2 pairs); submarginal vein with more than 2 dorsal setae; notauli complete, extending to posterior margin of mesoscutum; funicle 2-segmented; postmarginal vein distinctly longer than (about 2×) than stigmal vein.

Discussion.—There are only two Nearctic species in the genus *Diaulinopsis*, and a key to these was provided by Gordh and Hendrickson (1979). The host of *D. albiscapus* (Girault) is unknown. More complete information on hosts, distribution and synonymies is given in Gordh and Hendrickson (1979), Peck (1963) and Burks (1979b).

*Diaulinopsis callichroma* Crawford  
(Figs. 17, 42)

This is the only Nearctic species of *Diaulinopsis* that is known to parasitize *Liriomyza*.

Distribution.—Throughout the southern portion of the United States; also Mexico, West Indies, northern South America.

Hosts.—Several species of Agromyzidae.

## FAMILY PTEROMALIDAE

Genus *Halticoptera* Spinola

Diagnosis.—This is the only pteromalid parasite of *Liriomyza* known from North America. It is easily distinguishable from the other parasites (Eulophidae) because it has 5-segmented tarsi (instead of 4) and the antenna has 6 funicular segments (instead of 3 or 4).

Discussion.—There has not been a recent revision of Nearctic *Halticoptera*. The European species were treated by Graham (1969), who provided a key to species, and host and distributional information. Information on hosts and distribution, and synonymies are given by Peck (1963; *H. circulus* treated as *H. patellana*) and Burks (1979a).

*Halticoptera circulus* (Walker)

This is the only Nearctic species of *Halticoptera* known to parasitize *Liriomyza*. Due to misidentifications, this species has previously been treated under the names *H. aenea* and *H. patellana*.

Distribution.—Wide distribution throughout United States and southern Canada; also Mexico and Europe.

Hosts.—Species in several genera of Agromyzidae

## ACKNOWLEDGMENTS

The authors would like to thank the following for their assistance: G. Gordh and K. Heinz for critical reading of the manuscript; M. E. Schauff for the loan of material; G. Gordh for allowing the use of illustrations of *Zagrammosoma*. This research was supported, in part, by the American Floral Endowment.

## LITERATURE CITED

- Boucek, Z. 1965. Studies of European Eulophidae, IV: *Pediobius* Walk. and two allied genera (Hymenoptera). Acta Entomologica Musei Nationalis Pragae 36: 5–90.
- . 1988. Australasian Chalcidoidea (Hymenoptera). A Biosystematic Revision of Genera of Fourteen Families, with a Reclassification of Species. C. A. B. International, England. 832 pp.
- Boucek, Z. and R. R. Askew. 1968. Palearctic Eulophidae (excl. Tetrastichinae). (Hym. Chalcidoidea). Index of Entomophagous Insects. Le François, Paris. 260 pp.
- Burks, B. D. 1966. The North American species of *Pediobius* Walker (Hymenoptera: Eulophidae). Proceedings of the Entomological Society of Washington 68(1): 33–43.
- . 1979a. Family Pteromalidae, pp. 768–835. In Krombein, K. V. et al., Catalog of Hymenoptera in America North of Mexico. I. Symphyta and Apocrita (Parasitica). Smithsonian Institution Press, Washington, D.C. 1198 pp.
- . 1979b. Family Eulophidae, pp. 967–1022. In Krombein, K. V. et al., Catalog of Hymenoptera in American North of Mexico. I. Symphyta and Apocrita (Parasitica). Smithsonian Institution Press, Washington, D.C. 1198 pp.
- Christie, G. D. and M. P. Parrella. 1987. Biological studies with *Chrysocharis parksi* [Hym.: Eulophidae] a parasite of *Liriomyza* spp. [Dipt.: Agromyzidae]. Entomophaga 32(2): 115–126.
- Crawford, J. C. 1912. Descriptions of new Hymenoptera, No. 5. Proceedings of the U.S. National Museum 43: 163–188.
- Gordh, G. 1978. Taxonomic notes on *Zagrammosoma*, a key to the nearctic species and descriptions of new species from California (Hymenoptera: Eulophidae). Proceedings of the Entomological Society of Washington 80(3): 344–359.
- Gordh, G. and R. Hendrickson, Jr. 1979. New species of *Diglyphus*, a world list of the species, taxonomic notes and a key to new world species of *Diglyphus* and *Diaulinopsis* (Hymenoptera: Eulophidae). Proceedings of the Entomological Society of Washington 81: 666–684.
- Graham, M. W. R. deV. 1959. Keys to the British genera and species of Elachertinae, Eulophinae, Entedontinae and Euderinae (Hym., Chalcidoidea). Transactions of the Society for British Entomology 13(10): 167–204.
- . 1969. The Pteromalidae of North-Western Europe (Hymenoptera: Chalcidoidea). Bulletin of the British Museum (Natural History), Entomology Supplement 16: 1–908.
- Hansson, C. 1985. Taxonomy and biology of the Palearctic species of *Chrysocharis* Förster, 1856 (Hymenoptera: Eulophidae). Entomologica Scandinavica, Supplement 26: 1–130.
- . 1987. Revision of the New World species of *Chrysocharis* Förster (Hymenoptera: Eulophidae). Entomologica Scandinavica, Supplement 31: 1–87.
- . 1990. A taxonomic study of the palearctic species of *Chrysonotomyia* Ashmead and *Neo-*

- chrysocharis* Kurdjumov (Hymenoptera: Eulophidae). *Entomologica Scandinavica* 21: 29–52.
- Heinz, K. M. and M. P. Parrella. 1990. Holarctic distribution of the leafminer parasitoid *Diglyphus begini* (Hymenoptera: Eulophidae) and notes on its life history attacking *Liriomyza trifolii* (Diptera: Agromyzidae) in chrysanthemum. *Annals of the Entomological Society of America* 83:916–924.
- Hendrickson, R. M., Jr. and S. E. Barth. 1979. Introduced parasites of *Agromyza frontella* (Ron-dani) in the USA. *Journal of the New York Entomological Society* 87(2): 167–174.
- Johnson, M. W. and A. H. Hara. 1987. Influence of host crop on parasitoids (Hymenoptera) of *Liriomyza* spp. (Diptera: Agromyzidae). *Environmental Entomology* 16: 339–344.
- LaSalle, J. 1989. Notes on the genus *Zagrammosoma*, with the description of a new species. *Proceedings of the Entomological Society of Washington* 91(2): 193–199.
- Lema, K. M. and S. L. Poe. 1978. Juvenile hormone analogs: Effects of ZR-777 on *Liriomyza sativae* and its parasites. *Florida Entomologist* 61: 67–68.
- Miller, C. D. 1970. The Nearctic species of *Pnigalio* and *Sympiesis* (Hymenoptera: Eulophidae). *Memoirs of the Entomological Society of Canada* 68: 1–121.
- Minckenberg, O. P. J. M. and J. C. van Lenteren. 1986. The Leafminers *Liriomyza bryoniae* and *L. trifolii* (Diptera: Agromyzidae), their parasites and host plants: A review. *Agricultural University of Wageningen Papers* 86–2: 1–50.
- Oatman, E. R. and G. G. Kennedy. 1976. Methomyl induced outbreak of *Liriomyza sativae* on tomato. *Journal of Economic Entomology* 69: 667–668.
- Oatman, E. R. and G. R. Platner. 1969. An ecological study of insect populations on cabbage in southern California. *Hilgardia* 40: 1–40.
- Parrella, M. P. 1982. A review of the history and taxonomy of economically important serpentine leafminers in California. *Pan-Pacific Entomologist* 58: 302–308.
- Parrella, M. P. and K. L. Robb. 1985. Economically important members of the genus *Liriomyza* Mik: A selected bibliography. *Entomological Society of America, Miscellaneous Publications* 59: 1–26.
- Peck, O. 1963. A catalogue of the Nearctic Chalcidoidea (Insecta: Hymenoptera). *Canadian Entomologist, Supplement* 30: 1–1092.
- . 1985. The taxonomy of the Nearctic species of *Pediobius* (Hymenoptera: Eulophidae), especially Canadian and Alaskan forms. *Canadian Entomologist* 117: 647–704.
- Peck, O., Z. Boucek, and A. Hoffer. 1964. Keys to the Chalcidoidea of Czechoslovakia (Insecta: Hymenoptera). *Memoirs of the Entomological Society of Canada* 34: 1–120.
- Spencer, K. A. 1973. *Agromyzidae* (Diptera) of economic importance. *Series Entomologica*, 9. The Hague: W. Junk. 418 pp.
- . 1981. A revisionary study of the leaf-mining flies (Agromyzidae) of California. *University of California, Division of Agricultural Sciences Special Publication Number* 3273. 489 pp.
- Spencer, K. A. and G. C. Steyskal. 1986. *Manual of the Agromyzidae* (Diptera) of the United States. U.S. Department of Agriculture, *Agricultural Handbook* No. 638: 1–478.
- Yoshimoto, C. M. 1978. Revision of the subgenus *Achrysocharella* Girault of America north of Mexico (Chalcidoidea, Eulophidae: *Chrysonotomyia* Ashmead). *Canadian Entomologist* 10: 697–719.